ALGORITHMIC GARDENING –
Fieldguide for Pulling Weeds in a Mobile Garden

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/*
  How do you instruct a robot to identify and pull a weed? The Taurus dexterous robot
  prototype addressed in this program is equipped with stereoscopic computer vision,
  two dexterous arms with 7 degrees of freedom, and precision pincer appendages able
  to grip, pull and cut.

  This prose-based algorithmic fiction and the accompanying annotations are an attempt
  to think about how culture and politics are coded into algorithms.

  The technological steps alluded to here are the artists' interpretations of the
  explanations offered by industrial engineering PhD student Glebys T. Gonzalez in
  October 2018 and the experiments in image-processing carried out by Electrical and
  Computer Engineering ME student Arjun Narang in 2016. We thank them for their
  generous contributions and willingness to participate in this project.

  All errors, omissions and oversimplifications are the fault of the artists alone.

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       // Visually record the world around you:
1    Create an image data set by recording, over a specified period of time, mobile
2    Soybot gardens comprised of soybean plants, weeds and the moving robot platform.
3
4    Go through the camera images pixel by pixel, line by line, separating
5    background pixels from weed pixels based on their color.
6
7    Based on this separation, have humans edit and confirm the weed pixels and the
8    background pixels. These labels will be called the "ground truth."
9      // What is a weed? What is a plant (background)? What else is in the background?
10     // The answers, defined by humans, comprise ground truth.
11
12   Split the labeled images into two groups: a training set and a testing set.
13
14   Discover relationships that define weed pixels: use structured prediction on the
15   training set to label weed pixels based on the distribution of features around them.
16     // What is a weed? How do you recognize one? What is your evidence?
17
18   Use the trained prediction algorithm on the testing set and compare the predicted
19   labels with the ground truth labels. Proceed to the next step, if there is a high
20   level of success in identifying weeds.
21     // Do you see a weed?
22     // Are you sure it is a weed? How sure are you?
23     // If you fail to identify the weeds correctly, repeat steps 3-5 until you are very
24     // certain and the humans agree.
25
26     // You are now ready to work with live plants:
27   Use depth information from the stereoscopic camera to position correctly labeled
28   pixels in 3D space and create a point cloud model of the weed.
29
30   Generate the coordinates of a picking point for the weed by comparing the 3D point
31   cloud model of the weed against a model with an annotated picking point.
32     // Humans will help you again, by supplying models of weeds with the best points
33     // for picking them.
34
35     // What is the best path by which to approach the picking point of the weed?
36   Use a path planning algorithm to move the most advantageously positioned arm to the
37   picking point. In doing so, minimize energy expenditure, follow the smoothest path
38   available and avoid navigating through the soybean plants.
39
40   Close grippers around the picking point, pull up and move the arm to a defined drop
41   off point for the weed. Avoid moving through the soybean plants. Do not drop the weed
42   (yet). Wait for further instructions.
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